Atherosclerosis is a systemic inflammatory disease of the arterial wall that remains the leading cause of mortality and morbidity in industrialized nations. The importance of carotid atherosclerosis in the pathogenesis of cerebral events as Stroke and Transient Ischemic Attack (TIA) has been recognized. Most of the acute manifestations of atherosclerosis are caused by rupture of an atherosclerotic plaque (plaque containing deposits of fatty substances, cholesterol, cellular waste products, calcium, inflammation, blood vessels and other substances build up in the inner layer of an artery). Vulnerable plaques in the carotid artery have high probability to rupture, block smaller blood vessels in the brain, thus causing cardiovascular events. Intra plaque inflammation and new blood vessels (called neovascularization) are considered as main reason for plaque vulnerability. Therefore, indication for carotid surgery, which is commonly based on the degree of stenosis (> 70%), may be insufficient, and risk evaluation based on the plaque composition would be valuable in the treatment decision process. Thus, developing a noninvasive imaging method to assess plaque vulnerability on the basis of plaque vascularization is highly relevant.

By using ultrasound imaging system and contrast media which is injected to the blood stream, one can obtain better visualization of the blood vessels inside the plaque. In this presentation we will focus on a semi-automatic algorithm that was developed for quantification of the intra-plaque blood vessels. The algorithm includes advanced image processing methods for motion compensation of undesired movements and detection of contrast regions within the plaque. The algorithm tracks those contrast objects and classifies them into blood vessels and artifacts by using the temporal motion patterns of the detected objects. By ignoring the artifacts, it enables much more accurate analysis of the neovascularization inside the plaque. After applying the above steps, an arterial tree of these intra-plaque neovessels is reconstructed, and a 4-level neovascularization grading is done.

Quantitative analysis of the neovascularization flow and reconstruction of the intra-plaque arterial tree is a novel idea which enables risk evaluation of plaque vulnerability, allows population screening and thus may help to forecast and prevent stroke.

Our findings show that the technique is feasible and valuable in evaluating intra-plaque neovascularization grading. The method provides efficient analysis with minimal user interaction and agrees well with manual and visual validations.